The effect is to compress H in one half and expand it in the other half of a period, with corresponding strengthening and weakening of intensity, and also with a shifting of the nodes towards the compressed part. When u/v is made large, there is a great concentration at $\phi_1=\phi_0=\frac{1}{2}\pi$, $2\frac{1}{2}\pi$, $4\frac{1}{2}\pi$, &c., with only a weak disturbance of opposite sign between them. That is, there is a tendency to turn the original simply periodic vibration into periodic pulses, which become very marked as u increases towards v. The radiation of energy is very rapid. It involves (*l.c.*) the factor $(1-u^2/v^2)^{-2}$. This becomes so great as seemingly to shut out the possibility of anything more than momentary persistence of revolution. But there might be a solitary partial revolution, or nearly complete, in cometary fashion, which would generate a single pulse, if there cannot be a sequence of several at speeds nearly equal to that of light.

Three suggestions have been made about the X-rays. Röntgen suggested a longitudinal ether disturbance. This has not found favour, because it requires a new theory of electricity. Schuster suggested very rapid vibrations. This is tenable, because in the inside of an atom rudimentary calculations show that vibrations much more frequent than light are easily possible with revolving electrons. Stokes suggested collisional pulses. This is tenable too, for the collisions must produce electromagnetic pulses. I think X-rays are mixed Stokes pulses and Schuster vibrations, the latter arising from the atoms of the body struck. Now a pulse is not the same as a continued vibration, though it may be analysed into the sum of various sorts of continued vibrations, just as the distorted simply periodic vibration in (5) above may be. There ought, then, to be a physical difference between the effects of collisional pulses and continued very rapid vibrations. Apart from the emission of electrons and matter, there might be six sorts of radiation at least, say, light vibrations, below light, above light, collisional pulses, cometary pulses, and possibly periodic pulses. The last may have to be excluded for the reason mentioned. The cometary pulses would resemble the collisional pulses, though less dense. The above light vibrations need not require u/v to be more than a small fraction, though even then their maintenance is a difficulty. They require renewal again and again, perhaps in a collisional manner. There is a good deal to be found out yet in the relations of electricity to matter. There is also sometimes a good deal of misconception as to the relations of theory to fact. A purely dynamical theory of electricity, like Maxwell's, can give no information about the connection between electricity and matter. For example, Zeeman's experiment, as interpreted by Lorentz, brought out the striking fact that it was the negative electricity that revolved, not seemingly the positive, and the fact harmonises with J. J. Thomson's negative corpuscles. Theory could never predict such a fact, because it is not in the theory. It could not be there, because it has no dependence upon the dynamics of electricity in the theory. The same may be said of various other new facts much discussed of late. Now, though the theory cannot predict such facts, it is useful, of course, as a guide in framing hypotheses to account for the new facts, for it is no use flying in the face of solid theory. Whether the solid theory itself (not meaning that the ether is solid) will need to be altered remains to be seen. There is no sign of it yet, though I cannot believe the ethereal theory is complete.

To analyse the dopplerised vibrations expressed by (1), (2) into simply periodic vibrations seemed to involve very complicated work at first, save just for two or three terms. But there is a trick in it, which, when found, allows the complete expansions to be developed in a few lines. First show that (this is the trick)

$$\alpha^3\cos\phi_1=-\frac{d^2}{d\phi_0^2}\cos\phi_1,\quad \alpha^3(\sin\phi_1-\beta)=-\frac{d^2}{d\phi_0^2}\sin\phi_1. \quad (6)$$

Next, by the theorem known as Lagrange's, $\sin\phi_1$ can be at once put in the form of a series involving the derivatives of various powers of $\cos\phi_0$. Do not find the derivatives from them, but put $\cos^n\phi_0$ in terms of the sum of first powers of cosines by the well known circular formula. The full differentiations, not forgetting those in (6), may then be done at sight in one operation. The result is

$$\alpha^3(\sin\phi_1-\beta)=\sin\phi_0-\beta\,.\,2\cos 2\phi_0-\frac{3}{8}\beta^2(9\sin 3\phi_0+\sin\phi_0)$$
$$+\frac{4}{3}\beta^3(4\cos 4\phi_0+\cos 2\phi_0)+\frac{\beta^4}{\lfloor 4}\frac{1}{2^4}\Big(5^5\sin 5\phi_0+5\cdot 3^4\sin 3\phi_0$$
$$+10\sin\phi_0\Big)-\frac{\beta^5}{\lfloor 5}\frac{1}{2^5}\Big(6^6\cos 6\phi_0+6.4^4\cos 4\phi_0+15.2^4\cos 2\phi_0\Big)$$
$$-\ldots(7)$$

and so on to any extent. Then, to find the other one, differentiate the series in (7) with respect to ϕ_0 and divide the nth term by n. Thus

$$\alpha^3\cos\phi_1=\cos\phi_0+2\beta\sin 2\phi_0-\frac{\beta^2}{8}\Big(27\cos 3\phi_0+\cos\phi_0\Big)-\ldots(8)$$

and so on. This analysis of the vibrations is useful in some special developments, but of course the original distorted simple vibration is the most significant. In fact, the result of the analysis exhibits the common failing of most series developments that the resultant meaning is not evident.

Another way. Use Bessel's series for the sine and cosine of ϕ_1, and then carry out (6). It is remarkable that the relation between the eccentric and mean anomaly in a planetary orbit should be imitated, for the dynamics is quite different.

When I was a young child I conceived the idea of an infinite series of universes, the solar system being an atom in a larger universe on the one hand, and the mundane atom a universe to a smaller atom, and so on. I do not go so far as that now, but only observe that there is a tendency to make the electrons indivisible, and all exactly alike. But they must have size and shape, and be therefore divisible. Unless, indeed, they are infinitely rigid. Or they may vary in shape without dividing. There are infinite possibilities in the unknown. Kaufmann's measurements go to show that the mass of an electron, if there is any, is only a small fraction of its effective electromagnetic mass, although that is not a definite quantity subject to the Newtonian second law. But it is too soon to say that the electron has no mass at all, that is, to be quite sure that negative electricity is absolutely separable from matter, though it seems likely. It would be well to have, if possible, similar measurements made on positive electricity. If permanently attached to matter, it should not exhibit the increased inertia with increased speed in a sensible manner.

January 11. OLIVER HEAVISIDE.

Atmospheric Electricity.

YOUR correspondent Mr. George Simpson truly points out that the sun's α rays would be stopped by the upper atmosphere, whereas his β rays would penetrate much further; and perhaps he may have also noticed that an energetic separation of these oppositely charged rays would be effected by the earth's magnetic field, the negative being conveyed toward the poles, and the positive remaining near the tropics along with the maximum sunshine.

Consequently quadrantal earth-currents would be generated, and likewise a Leyden jar action would be set up in the tropical region of the lower atmosphere, sufficient to account for prevalent tropical thunderstorms. Some magnetic perturbations could also be accounted for.

OLIVER LODGE.

Nomenclature and Tables of Kinship.

A CIRCULAR letter, arranged like the following, is about to be issued for carrying out certain inquiries into heredity, and I am anxious, before taking a more definite step, to have it criticised and to receive suggestions. I send it to NATURE not only for my own advantage, but because I think it will interest those readers who occupy themselves in analysing experiences in breeding animals of any kind, although this table has been specially designed to receive hereditary facts concerning man.

The processes that it is desired to facilitate are, in out-

line, as follows:—Some marked peculiarity is determined on to be made the subject of study. It may be an excess or deficiency of some normal character, or it may be a trait, a feature, a disease, or a monstrosity, the process being the same in all these cases. The inquirer then endeavours to trace its hereditary distribution. He fixes upon some individual who possesses the peculiarity in a highly marked degree, and traces the frequency and intensity with which it occurs among his kinsmen. He tries to do so exhaustively by compiling the facts relative to those kinsmen in each and every degree to as great a distance of kinship as he is able, or cares, to go. He follows a similar course in respect to many other individuals belonging to as many different families, and finally he obtains average results by well-known methods. I am speaking solely of inquiries

Distribution of the Peculiarity X *in the Family of* A. B.

fa=Father or father's, according to its place; similarly, *me*=Mother; *bro*=Brother; *si*=Sister; *so* (or *son* where more euphonious)=Son. The links in the chain of kinship are to be read as leading outwards from A.B. Thus, *me da* signifies "A.B.'s mother's daughter is." *fa bro son* means "A.B.'s father's brother's son is."

Ordinary names for generalised kinships	Titles showing the precise chain of kinships	Adults alone: Total No. of sons and daus	Adults alone: Initials of those whose X deserves record	Titles showing the precise chain of kinships	Adults alone: Total No. of sons and daus	Adults alone: Initials of those whose X deserves record	Names in full of those whose initials appear in the preceding column
Grandfather Grandmother	*fa fa* *fa me*	1 1		*me fa* *me me*	1 1		
Uncles ... ... Aunts	*fa bro* *fa si*			*me bro* *me si*			
Father ... ... Mother... ...	*father* *mother*	1 1		— —	— —	— —	
Brothers ... Sisters	*brother* *sister*			— —	— —	— —	
Half-brothers Half-sisters	*fa son* *fa da*			*me son* *me da*			
Nephews ... Nieces	*bro son* *bro da*			*si son* *si da*			
First cousins Male ...	*fa bro son* *fa si son*			*me bro son* *me si son*			
First cousins Female...	*fa bro da* *fa si da*			*me bro da* *me si da*			

Maiden name of the wife	Year of marriage	Number who survived infancy: sons	Number who survived infancy: daus	Initials of those whose X deserves record

directed to what I would call the *actuarial* side of heredity, because they are analogous to those made by actuaries with medical experiences to determine the just rates of insurance in respect to expectation of life and other vital phenomena.

The ambiguity and cumbrousness of the ordinary terms of kinship are serious obstacles in carrying out these researches; it is also very difficult to present the results in a compact form by any established method. I have endeavoured to overcome both difficulties, the latter by the arrangement of the present table, and the former by the use of syllables, which give a perfectly distinctive description, and which, in addition to the advantage of brevity, have those of being easily intelligible, euphonious, even though they may be a trifle absurd, and capable of the most extended application. The details of the peculiarity X, as they appear in the several persons named in the last column of the table, are supposed to be entered in a corresponding number of paragraphs on a separate sheet. After more trials and failures than would be easily credited, I think I have at last succeeded fairly well. Still, as I began by saying, I should be very grateful for useful suggestions. The table admits of indefinite extension, with no alteration of method. It will, of course, be understood that each successive step in the line of descent introduces a new element that may seriously affect the previous influences. Much might be added, but I think that with the aid of a little reflection the arrangement of the table will explain and justify itself. FRANCIS GALTON.

The Source of the Energy of Radium Compounds.

IF I understand Prof. Rutherford's communication aright (NATURE, January 7, p. 222), he concludes from the constancy of radio-active results with a solid radium salt and the same diluted that the energy of radium compounds cannot be derived from external sources. The matter is of such wide scientific interest that I ask your permission to present concisely the contra argument.

(1) When a coloured solid is dissolved the amount of absorption of light effected by the solid is equal to the amount of light absorbed by its solution. Thus I have shown that a plate of solid bichromate of potash 0·71 millimetre in thickness effects the same absorption of light as 6 centimetres of solution containing 0·0309 gram of the salt per cubic centimetre, as in each case the same number of bichromate molecules or molecular aggregates is acting on the light. To be perfectly clear, taking the specific gravity of bichromate of potash as 2·617, we have in the former case a rectangular bundle of rays 1 square centimetre in section passing through $0{\cdot}71\times0{\cdot}2617=0{\cdot}1858$ gram of solid, while the bundle of rays in the latter case passes through $6\times0{\cdot}0309=0{\cdot}1854$ gram of dissolved bichromate (see *Chem. News*, October 5, 1877).

(2) It has been amply demonstrated that the absorption of X-rays follows the same general laws as the absorption of light; thus the amount of both kinds of radiation absorbed increases (1) with the thickness of the body passed through, and (2) with the molecular weight in a comparable series of bodies ("The Old Light and the New," 1896, pp. 73–80).

Therefore if it be postulated that the energy of radium is due to the absorption of "an unknown external radiation" "similar in character to the radiations which are emitted," viz. the γ rays, then the mere act of dilution of a milligram of radium bromide will not affect its constancy of absorption, and therefore also will not materially influence its radio-activity. WILLIAM ACKROYD.

Borough Laboratory, Halifax, Yorks.

γ-Rays from Radium.

FROM the letter of Prof. Rutherford in NATURE of January 7 it is improbable that γ rays from radium are Röntgen rays generated by self-bombardment. The γ rays must therefore arise from radium directly, and not as a secondary effect of bombardment.

It may be useful here to recall a remark made by Sir George Stokes at a meeting of the physical colloquium of the Owens College, Manchester, shortly before his death. Commenting on Becquerel rays, he likened the discharge of kathode rays to the discharge of a gun, the impact of kathode projectiles on a target creating an ethereal disturbance recognised as Röntgen rays. But, he said, in the same way as there is an explosive disturbance in the gun where the bullets issue, so there must also be a violent ethereal disturbance, not only where kathode rays strike, but also where they issue.

Is it not just this disturbance where β rays issue which is now being detected in γ rays, and is it not quite consistent with this view that the explosive disturbance of the atom which produces α and β rays should at the same time generate something akin to Röntgen rays?

J. R. ASHWORTH.

105 Freehold Street, Rochdale, January 16.